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Speech Science Research Centre

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Susan Peppé, Joanne McCann, Fiona E. Gibbon,  
Anne O'Hare and Marion Rutherford

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Author Contact details:

- 2006 onwards at [speppe@qmuc.ac.uk](mailto:speppe@qmuc.ac.uk)

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# Assessing prosodic and pragmatic ability in children with high-functioning autism

## **Authors:**

Sue Peppé (for correspondence): [speppe@qmuc.ac.uk](mailto:speppe@qmuc.ac.uk)  
Speech and Hearing Sciences, Queen Margaret University College,  
Clerwood Terrace, Edinburgh, EH12 8TS

Joanne McCann  
Fiona Gibbon  
Anne O'Hare  
Marion Rutherford

## **Abstract:**

Children with high-functioning autism are widely reported to show deficits in both prosodic and pragmatic ability. New procedures for assessing both of these are now available and have been used in a study of 31 children with high-functioning autism and 72 controls. Some of the findings from a review of the literature on prosodic skills in individuals with autism are presented, and it is shown how these skills are addressed in a new prosodic assessment procedure, PEPS-C. A case study of a child with high-functioning autism shows how his prosodic skills can be evaluated on the prosody assessment procedure, and how his skills compare with those of controls. He is also assessed for pragmatic ability. Results of both assessments are considered together to show how, in the case of this child, specific prosodic skill-levels can affect pragmatic ability.

## **1. Introduction**

Prosody plays an important role in a range of communicative functions, affective, pragmatic, and syntactic (Roach, 2000, and others). As a feature of impaired communication in autism, individuals often display disordered prosody; this feature was included in Kanner's original description of autism (Kanner, 1943) and has been re-affirmed since (e.g. Fay and Schuler, 1980, Baltaxe and Simmons, 1985). Disordered prosody in people with autism varies widely. In some individuals intonation is exaggerated, in others monotonous, i.e. dull, wooden or flat (Fay and Schuler, 1980). Such descriptions are, however, impressionistic; and unquantifiable as they stand.

The following points constitute more reasons to think that prosody may be closely associated with autism. People with autism tend to be literal in their interpretation of language, and to have difficulty understanding metaphor (Tager-Flusberg, 1999); aspects of communication that are inferred intuitively by the typically-developing child, such as the use of prosody, may therefore present particular problems for them. Moreover, verbal and non-verbal language impairment is a diagnostic feature of autism, and the 'prosodic bootstrapping hypothesis' (Gleitman and Wanner, 1982; Morgan and Demuth, 1996) suggests that the development of linguistic structures depends to some extent on sensitivity to prosodic patterns, which assists infants to segment the stream of speech that they initially hear: language development may thus be adversely affected if the processing of prosodic information is defective. People with autism are furthermore widely acknowledged to have impaired theory of mind (ToM) skills, i.e. the ability to impute mental states to others (Baron-Cohen, Leslie and Frith, 1985); mental and emotional states are often conveyed by prosody, and so receptive prosodic deficit could either cause a paucity of indications of the mental and emotional states of others, or be caused by poor understanding of the fact that prosody may convey thoughts and emotions that differ from one's own. Children with autism are also known to have pragmatic problems, i.e. to have difficulty in orienting appropriately to conversational situations, and these may depend to some extent on prosodic ability, both receptive and expressive.

Atypical expressive prosody affects communication in different ways. Linguistic/pragmatic content may be changed by monotonous speech (speech with narrow pitch-range): for example, prosodic phrasing and emphasis are likely to be lost, and conversational indications (e.g. whether or not the speaker has finished speaking) may be attenuated; additionally, it may give the (possibly erroneous) impression that the speaker is depressed. Prosody that is exaggerated (wide pitch-range) might be inappropriate and misinterpreted as patronising or insincere, although it is unlikely to affect the linguistic/ pragmatic content of what is said (i.e. the speaker is not likely to be linguistically misleading). Perhaps most importantly, however, an unusual way of speaking, or an exotic accent, is likely to affect social acceptance: speakers may be deemed 'bizarre' (Fay and Schuler, 1980). Atypical expressive prosody may be caused by receptive prosodic deficit, as (arguably) receptive prosodic ability is necessary for informing prosodic expressiveness. As indicated in the previous paragraph, however, receptive deficit may affect not just expressive prosody but language development and pragmatic and social skills as well.

Despite this, comparatively little research has been undertaken in this area, with research into receptive aspects of prosody particularly neglected (McCann and Peppé, 2003). Although a comprehensive evaluation of the role of prosody (or a 'prosody

component') in autism is desirable, the scope of the present paper is to consider some of the reasons why assessing prosodic ability in autism has been problematic and how the study reported here has attempted to overcome them.

### ***1.1. Assessment of prosody***

There are few established procedures for assessing prosody. It is one of the aspects investigated in some tests as in the Frenchay Dysarthria Assessment (Enderby, 1983), and a number of ad hoc tasks have been created for particular experimental situations; but, in the UK at least, there is currently no standardised test in regular use by clinicians. In Sweden there is now a test (Samuelsson, Scocco and Nettelbladt, 2003), and in the USA there is the Prosody Voice Screening Profile (Shriberg, Kwiatkowski and Rasmussen, 1990). Neither of these assesses receptive prosodic ability.

### ***1.2. Previous studies of prosody in autism***

Studies are grouped by prosodic communicative function, and main findings are summarised here. For a complete review of studies to 2002, see McCann and Peppé, 2003.

#### ***1.2.1. Stress placement***

The most comprehensively covered area of research into prosody in autism is the placement of 'stress', part of the concept of pitch-accent (phrasal or sentential stress), i.e. the signalling of an important or contrastive word in an utterance, realised by variation in speech-rhythm and relative prominence of syllables. Most studies used perceptual analysis of conversation samples: several studies report misassigned contrastive stress compared with controls (e.g. Baltaxe, 1984 and McCaleb and Prizant, 1985). One study suggests that individuals with autism are more likely to stress the first element of utterances where the last element would have been more appropriate (Baltaxe and Guthrie, 1987). Shriberg, Paul, McSweeney, Klin, Cohen and Volkmar (2001) report that adults with HFA used stress appropriately in the majority of utterances, but there was still some evidence of difficulty with pragmatic and emphatic stress.

This indicates a fairly robust finding of impairment in stress-placement, but perceptual judgement of stress placement in conversation samples (as mainly used in these studies) raises methodological issues. The causes of misassigned stress are not clear: it is possible that the rules of stress assignment are being misapplied, leading to ill-formed stress that is nevertheless perceived as well-formed. It is also possible that unusual pragmatic agendas in autism may have led the individual to change stress-placement intentionally from where the experimenters expected it to occur: a conversation sample does not allow the possibility of ascertaining the reasons. Some studies used elicited not conversational data, but methods for eliciting were often unsatisfactory, e.g. requiring participants to repeat 'given' predicates. ("Is Mike sitting on the chair" was expected to elicit "No, *Pat* is sitting on the chair": Baltaxe, 1984)

One study considered the ability to perceive stress: Paul, Augustyn, Klin, Volkmar and Cohen (2000) report a small pilot study in which participants were asked to listen to single words differentiated by stress and make judgments about their

syntactic class, e.g. ‘*imprint*’ (noun) versus ‘*imprint*’ (verb). Participants with HFA were less able than controls to comprehend this difference.

### ***1.2.2. Emotion, attitude, affect***

A few studies have dealt with the ability of individuals with autism to understand affect as expressed by voice quality, intonation and paralinguistic features, but with variable findings. For instance, Boucher, Lewis and Collis (2000) report an inability to identify feelings that were expressed vocally (i.e. with variation of voice quality and intonation) but not verbally (i.e. by lexical content) in children with autism; and Rutherford, Baron-Cohen and Wheelwright (2002) found that adults with autism had impaired ability to recognise vocally expressed emotions when compared with typical adults; but Paul et al. (2000) found that children with autism and controls are both able to understand the difference between an ‘excited’ and a ‘calm’ utterance.

While these findings may appear to conflict, it is possible that the conflict is an effect of methodological difficulties. There is the problem of identifying emotions, which are not discrete and therefore do not lend themselves readily to categorising; additionally, labels for emotions may be low-frequency (see Rutherford et al., 2002) and mean different things to different people. There is also the problem of interference from the lexical content of utterances acting as stimuli, which needs to be controlled if it is not to provide clues as to the emotion to be identified. There is also the question of the degree of prosodic difference in the experimental condition: this could be merely clear enough for typical adults to be in no doubt as to the emotion being expressed, or so exaggeratedly clear that factors other than prosody provide clues; but this degree was not described in the experiments.

### ***1.2.3. Syntactic phrasing***

The segmentation of utterances for grammatical, pragmatic or semantic purposes can be achieved by prosody, i.e. by such features as pause, final syllable-lengthening and tone occurring at syntactic boundaries (Scott, 1982). In connection with this, several studies have examined the frequency and place of pauses in utterances in the speech of individuals with autism. Fosnot and Jun (1999) compared 4 children with autism, 4 typically developing children and 4 children who stuttered (aged between 7 and 14). The children with autism were more likely than the typically-developing children and the children who stuttered to use non-grammatical pauses (pauses that occur within phrases rather than at phrase boundaries), indicating either a lack of fluency or an inability to place pauses at boundaries, whereas Thurber and Tager-Flusberg (1993) found that children with autism used fewer non-grammatical pauses, suggesting greater fluency, than their typically-developing group. Shriberg et al. (2001) reported that 40% of adults with HFA in their study had inappropriate or disfluent phrasing on more than 20% of their utterances.

The conflict of findings may be an effect of sample size, but one problem with comparing these studies is that the authors were considering pausing as affecting fluency and being affected by cognitive load, as well as the use of pause for prosodic phrasing. As with stress-placement, there is the problem of knowing what phrasing is intended by the speakers, and this is not adequately accounted for by a judgment of appropriateness.

Regarding input skills, Paul et al. (2000) assessed ability to judge prosodic phrasing in syntactically ambiguous utterances and found that participants with HFA did less well in this task than the controls.

#### **1.2.4. Sentence-type**

Only one study was found that investigated the use of intonation to convey sentence-type in individuals with autism. Fosnot and Jun (1999) included an experiment that involved reading aloud sentences with and without question-marks. The children with autism, unlike the other children, tended to make all utterances sound like statements, but the number of participants was very small and the study assumed an ability to read and to understand what is meant by punctuation-marks.

#### **1.3. Research objectives**

It appeared from the literature addressing prosody in autism that assessment of both expressive and receptive prosodic skills was problematic. A new prosody assessment procedure (the PEPS-C, see below) addresses these problems, and this paper shows how it was used in a recent project investigating prosody in children with autism (described below), and how results from the procedure relate to a test of pragmatic skills (the CCC, see below). A case study is included as an example of how an assessment of prosodic ability in one child with autism, when taken in conjunction with a pragmatic assessment, may be of clinical use in determining the factors that contribute to communicative and social difficulties.

### **2. Methodology**

The previous summary of studies of prosody in autism suggests that assessment methodology may have been responsible for an unclear picture and conflict of findings. Studies in general involved few subjects with autism, a lack of control data, and broad definitions of autism, which is acknowledged to be a spectrum disorder (Wing and Gould, 1979). Some studies involve both adults and children, potentially a problem because some prosody skills develop late (Wells, Peppé and Goulondris, 2004).

#### **2.1. Prosody assessment procedure**

In this study a new prosody assessment procedure was used: Profiling Elements of Prosodic Systems in Children (PEPS-C). Originally a procedure used to assess prosody in adults (Peppé, 1998), the PEPS-C has norms available for 120 typically-developing Southern British English-speaking children (Wells, Peppé and Goulondris, 2004) and has been used with children with a variety of speech and language impairments (Wells and Peppé, 2003). The test has now been revised and computerised at Queen Margaret University College, Edinburgh (Peppé and McCann, 2003), and has been used in the recent project described in this paper, from which the data reported is taken.

The test was developed to assess prosody in speech and language disorders, addressing issues not covered by previous protocols. It is based on a psycholinguistic model, distinguishing between the phonetic and phonological levels of prosody, since one problem of assessment may be confusion as to what is being assessed. Prosodic terms (such as 'stress') can often refer either to prosodic function and/or to its exponency: the distinction is important because otherwise it is difficult to establish whether prosody problems are at the 'form' or phonetic level (in which the features of stress - pitch, loudness, duration – and their occurrence are themselves unusual or disordered) or at the 'functional' or phonological level, in which the linguistic use of



stress is disordered. These have been described by Crystal (1981) as, respectively, ‘dysprosody’ and ‘prosodic disability’. The test also includes assessment of receptive skills, notably lacking in previous procedures.

The PEPS-C assesses four communicative functions of prosody: the expression of attitudes and emotions (Affect); the delimitation of syntactic/linguistic units in speech (Chunking); the signalling of relations between conversational utterances by their type of closure (Turn-end); and the assignment of stress to linguistic elements (Focus). Each function is assessed in terms of both input (receptive) and output (expressive) skills in parallel tasks. At least two judges agreed that the stimuli for the input tasks indicated the functions unambiguously without being exaggerated. Judgements of responses are right or wrong for input tasks (scoring 1 or 0) and right, wrong or ambiguous in output tasks (right scores 1, wrong or ambiguous scores 0). Separate tasks in the procedure test the ability to perceive the auditory differences of the forms used to convey them and the ability to imitate these forms: judgments on input tasks score 1 or 0, while responses on output tasks are rated as good, fair or poor, (scoring 1, 0.5 and 0 respectively). All responses and judgments are recorded by the computer.

The test is described in some detail in Peppé and McCann (2003), and a schedule of the tasks is given in the Appendix.

### **2.1.1. Form Tasks: Intonation and Prosody.**

The underlying (form) skills required to complete the function tasks have been designated ‘Intonation’ and ‘Prosody’ respectively. Intonation is often thought of as part of prosody, but is used here to indicate variations in pitch/fundamental frequency, while ‘prosody’ is used for the combinations of variation in duration, pitch and loudness that signal stress/accent and boundary. Receptive (input) form skills are tested by means of auditory discrimination (‘same-different’) tasks. One task (Intonation input) tests intonation discrimination, in which the stimuli are those used in the Turn-end and Affect input tasks, i.e. rises versus falls and fall-rises versus rise-falls on single words. The other task (Prosody input) tests prosody discrimination and uses stimuli from the Chunking and Focus input tasks (phrases in which either the place of stress or the place of minor syntactic break varies). The stimuli are laryngograph recordings: the speaker of the stimuli wears a laryngograph microphone which records the audio signal from the larynx before the sound is modified by the articulators. The laryngograph recordings thus consist of intonational or prosodic information devoid of lexical content, something like conversation heard in another room. To assess the ability to produce different types of prosody and intonation two imitation tasks (Intonation output and Prosody output) are used. The children hear stimuli similar to those used in the corresponding input tasks (full speech, as opposed to laryngograph recordings) and are asked to “copy the word/phrase and make it sound exactly the same as the way you heard it”.

In a previous study (Wells, Peppé and Goulandris, 2004), it was hypothesised that output task performance would be higher in children who had done input tasks first; half the participants therefore did input tasks before output tasks and half vice versa, but no order effects were observed. In this study, we tested the hypothesis that function task scores would be better if the form tasks were done first; accordingly, half the children did form tasks before the related function tasks, i.e. Intonation tasks (IO and PO) before Turn-end (TI and TO) and Affect (AI and AO) tasks; Prosody tasks (PI and PO) before Chunking (CI and CO) and Focus (FI and FO) tasks, while half did function tasks before form tasks. Again there was no effect for order, except in one

task (Intonation Output - IO) where scores were lower ( $p < .01$ ) in participants who did form tasks first.

### **2.1.2. Function tasks**

#### **2.1.2.1. Turn-end**

As an example of distinction of sentence-type by intonation, the PEPS-C investigates children's ability to distinguish questions and declaratives. The difficulties presented by reading ability and the meaning of punctuation-marks are eliminated by using pictures. In the input task the children see two pictures: one that represents a question (a picture of someone offering some food) and another representing a statement (a picture of someone looking at a picture of the same food in a book). The accompanying auditory stimulus is of the name of the food said with intonation that is high rising (to indicate offering/questioning) or low falling (to indicate reading/stating). The testee selects the picture that best agrees with the stimulus. For the output task, the testee sees single food-items in either the 'offering' or the 'reading' situation and is asked to say the food-item as if in that situation. The tester judges from the testee's prosody which picture was shown or whether it is impossible to tell (ambiguous), and the computer notes match/mismatch between picture and prosody.

#### **2.1.2.2. Affect**

Feelings about food-items are used as an instance of affective function. Previous studies (e.g. Wells, Peppé and Goulondris, 2004) showed that an intonational rise-fall on the name of a food-item readily suggests liking, while a fall-rise suggests reservation. The two response-options are easily explained and the lexical content of food-items used as stimuli is neutral (items likely to elicit a predictable feeling, such as 'chocolate', are avoided). The feelings are identified by a happy face and a sad one, thus avoiding the need for semantic labels. For the input task, a food-item appears on the screen with an accompanying auditory stimulus - the name of the food said with rise-fall or fall-rise. The child's response is to select a happy or sad face as shown on the following screen. In the output task, the same food items appear and the testees produce the name of the food in a way that indicates whether or not they like it, using their own feelings as a guide. The tester assigns the child's feelings to one of the two options, and the faces then reappear so that testees can confirm their feelings by clicking on the appropriate face. This provides independent (non-prosodic) verification of the testee's target.

#### **2.1.2.3. Chunking**

These tasks address not fluency but the phrasing associated with minor syntactic boundaries, in which pauses, final lengthening and the presence of accent or tone combine to indicate phrase-ends. It makes use of lexically ambiguous phrases that can be disambiguated by prosody, with the different meanings implied by the prosody rendered pictorially. A phrase such as 'chocolate cake and jam' can have a phrasal break after 'cake' and be depicted as a picture of a chocolate-cake and one of jam, or it can have a break after 'chocolate' and be illustrated as separate pictures of chocolate, cake and jam. Similarly, the utterance 'red and green and black socks' can have a break after 'green', depicted by a pair of red-and-green socks and a pair of black socks, or after 'red' (a pair of red socks and a pair of green-and-black socks). The testees hear the phrases and select the picture appropriate to the prosodic phrasing. In the

corresponding output task similar pictures appear on the screen and the testee is asked to say what they see.

#### **2.1.2.4. Focus**

For the PEPS-C Focus task, the function of contrastive stress is used. In the input task, the children are required to identify the stressed or contrastive word in phrases such as “I wanted *blue* and black socks” where ‘blue’ is stressed. The output task involves ‘animal football’, played by variously-coloured sheep and cows; the child sees a picture of, for example, a white cow on the screen and hears a football commentator say: “Now the green cow has the ball...”. The child is instructed to correct the commentator; in this instance a correct response would be “No, the *white* cow has it”, with contrastive stress on ‘white’. Conversely, the cue might be: “Now the white sheep has it...” when a correct response would be “No, the white *cow* has it”. The expected place of accent is on thus on either the colour or the animal; in responses, the words will be the same (‘the white cow has it’), whether colour or animal is being stressed, but by listening to the response alone it is possible to tell which stimulus preceded it if it is correctly stressed. This is a more objective way of determining which word is stressed than a perceptual judgement.

#### **2.2. Pragmatic assessment**

The Children’s Communication Checklist (CCC, Bishop 1998) is a report by teachers or speech and language therapists which investigates a child’s communication skills via 70 questions in several categories, ranging from the purely linguistic through a blend of communicative and social pragmatic issues to purely social skills. Five scales, assessing inappropriate initiation, coherence, stereotyped language, use of context, and rapport are included and are combined to give a pragmatic composite score.

#### **2.3. The ‘Prosody in Autism’ project**

A two-year project funded by the Scottish Health Executive’s Chief Scientist Office investigated prosodic ability in children with autism, seeking to relate it to ability in other language parameters.

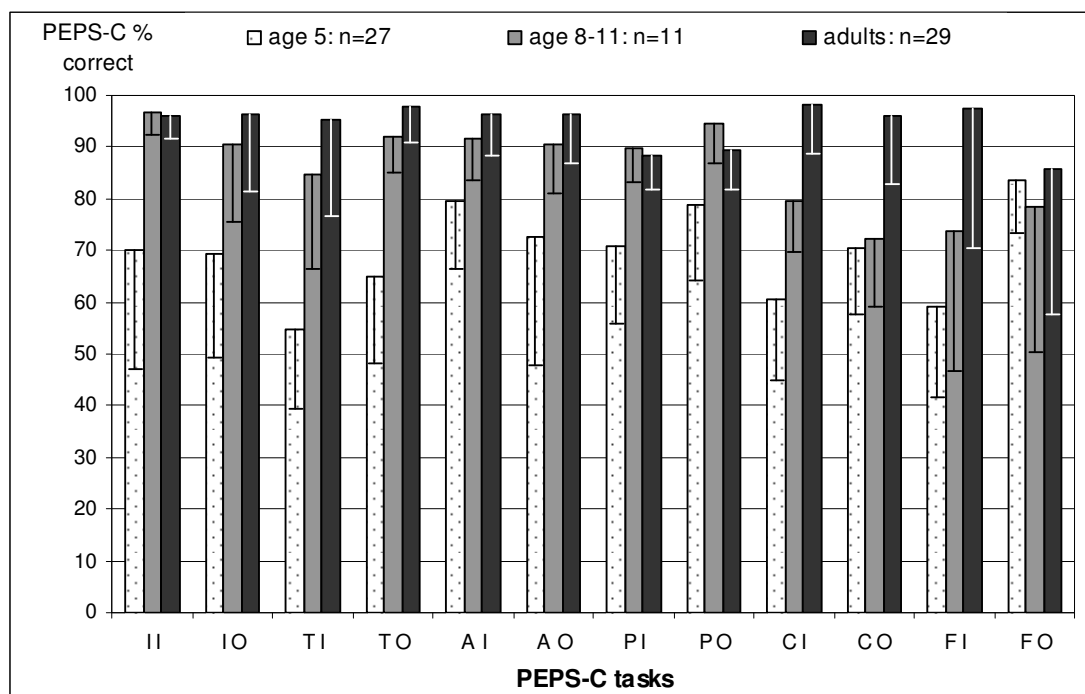
In order to avoid confounding variables from type of disorder, the experimental group was selected as having autism conforming to ICD-10 (World Health Organisation, 1993), with non-verbal ability within the normal range and receptive vocabulary and expressive language higher than 4;0 years age-equivalent; this was defined as high-functioning autism (HFA), and children with Asperger’s syndrome were not included. 31 children with HFA aged 6-13 years took part. As controls, since the PEPS-C is not standardised, 72 typically-developing (TD) children also completed the PEPS-C test: a relatively large number to ensure that there would be at least one match for each of the children with autism. The TD children were matched with the HFA group by sex and verbal mental age (VMA) and postcode as a measure of socio-economic status. VMA was assessed in both groups using the British Picture Vocabulary Scales (BPVS-II: Dunn, Dunn, Whetton and Burley, 1997) as in other studies of prosody in autism (e.g. Baron-Cohen, Leslie, and Frith, 1985; Thurber and Tager-Flusberg, 1993). Teachers and speech and language therapists completed the Children’s Communication Checklist, a procedure for assessing pragmatic skills (Bishop, 1998) for the children with HFA, who were also assessed on other

language/cognitive parameters. An evaluation of the interaction of prosody with other language skills in this group (McCann, Peppé, Gibbon, O'Hare and Rutherford) is in preparation and full results of this study are reported elsewhere: Peppé, McCann, Gibbon, O'Hare and Rutherford (in revision), McCann, Peppé, Gibbon, O'Hare and Rutherford (in preparation), and Gibbon, McCann, Peppé, O'Hare and Rutherford (submitted).

### 3. Results

Figure 1 shows prosodic data for 29 adults and 2 age-groups of the TD control group. To give an indication of how the children's scores increased with age, the scores of the youngest and oldest age-groups of the children are shown. The TD children were on the whole younger in chronological age (age-range 4;8 to 11;6) than the HFA group, since they were matched on verbal skills. There were therefore fewer children at the older ages and the oldest group includes all those aged 8-11. All the participants were from Edinburgh, Scotland, and the stimuli were recorded in the accent of that area. As an indicator of competence in the PEPS-C tasks, a pass-level was set at 75%. The reason for this apparently stringent criterion was to avoid misinterpretation of chance scoring. All of the input task items are binary choice, so scores >25% and <75% could have been obtained by chance. In the output tasks, if a child produces all test items with the same prosodic form this too can result in a chance score of 50% (each task having two targets), and scores >50% and <75% will indicate only weak ability.

*Figure 1. PEPS-C mean percentage scores of TD children in 2 age groups and adults, showing standard deviations from the mean as single-ended error bars*



The figure shows that the mean scores of adults are near ceiling on all tasks. That prosodic skills develop during childhood, and at different ages, has been established by a number of previous studies (e.g., Cruttenden, 1985; Beach, Katz and Skowronski,

1996; Snow, 1998; Wells, Peppé, and Goulandris, 2004), and this was borne out in the current study. For a full report of the performance of the HFA group on PEPS-C tasks, see Peppé, McCann, Gibbon O'Hare and Rutherford (in revision). After allowing for the developmental factor, statistical analysis showed the two groups to be significantly different ( $p < .01$ ) on all PEPS-C tasks except one (CO).

#### 4. Discussion: Case Study

Adam (not his real name) is aged 7;0 and comes from an Edinburgh home. His own accent is not typical of this area but shows no consistent similarity to any specific other accent of English. He attends a special language unit for children with autism. His articulation, non-verbal and receptive language skills are within the normal range, while his expressive language is significantly delayed. Perceptually, he is deemed to have disordered prosody: his speech appears abrupt, he has a mild tendency to syllable-timing, and makes frequent use of a steep falling pattern, which perhaps gives an impression of impatience, but occurs so frequently as to sound idiosyncratic rather than meaningful. His speech reflects some of the descriptions of atypical prosody in the literature.

*Figure 2. Comparison of Adam's PEPS-C percentage scores with the mean percentage scores of 9 VMA-matched TD children and 9 VMA-matched children with HFA, showing standard deviations from the mean as single-ended error bars.*

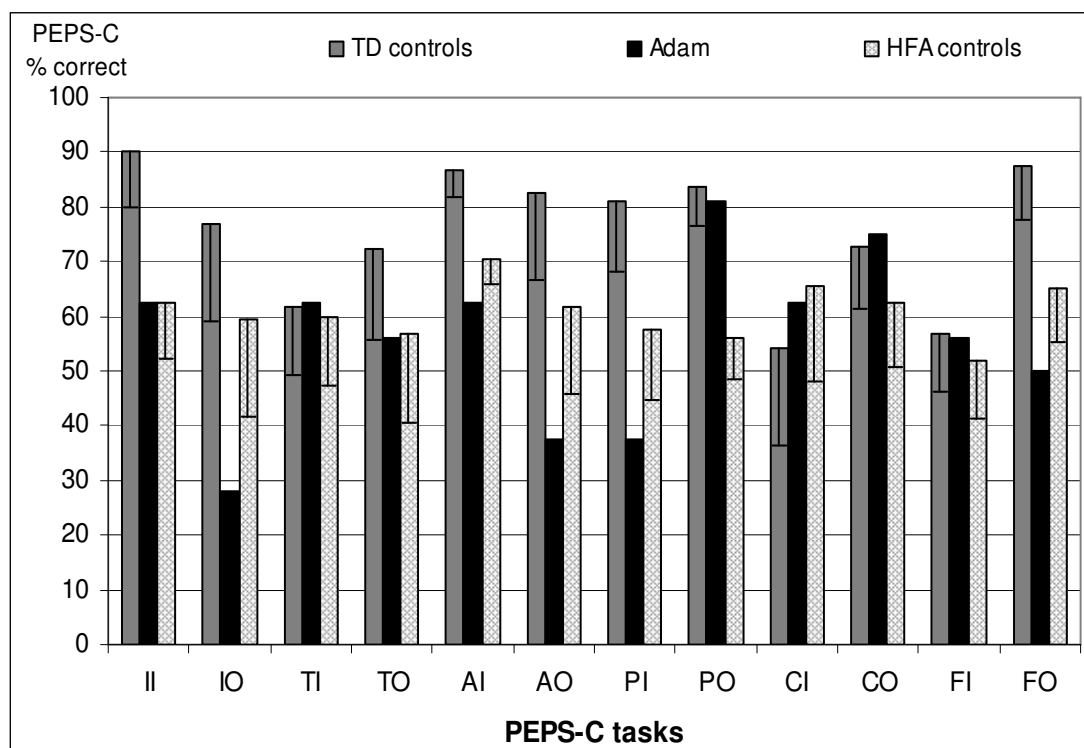


Figure 2 shows the PEPS-C tasks and Adam's performance compared with the mean scores of 9 boys with the same or similar socio-economic status and VMA (mean age-equivalent score 6.49), and with 9 children (two of whom were girls) with HFA, also of similar socio-economic status and with a mean VMA of 6.49. The

chronological ages of the TD children range from 5;5 to 6;9 (mean 6;2), those of the children with HFA from 6;1 to 13;5 (mean 9;8).

#### **4.1. Intonation and Prosody tasks**

Adam scored at chance in both the input form tasks (II and PI), suggesting that compared to his peers he has less auditory discrimination and/or auditory memory skills to distinguish types of prosody. On the Intonation task he was at 1.5-2 standard deviations and on the Prosody task at 3 standard deviations below the mean scores of the TD peer-group, which were well above the competence level. His peers with HFA scored at the same level as Adam on the Intonation task and at 1-1.5 standard deviations below the TD mean score on the Prosody task (significantly different,  $p < .01$ ). Adam has no hearing loss, but appears to have unusual auditory discrimination: examination of his errors showed that while he sometimes judged different stimuli to be the same, suggesting a lack of auditory discrimination, he more frequently judged similar stimuli to be different. This has not been satisfactorily explained, but may have been due to interference from ambient noise.

In the output tasks, he was 3 standard deviations below the mean score of his TD peer-group on the Intonation task, although his peers with HFA scored better than he did. He performed well, however, on the Prosody task, as did his TD peer-group, while his peers with HFA scored significantly lower than both Adam and the TD group.

There may have been a learning effect here: the Intonation output (IO) task would have been the second task Adam did in the test, the first being II (Intonation Input), and it is his poorest score. By contrast, he scores above competence-level on the Prosody Output (PO) task, which was the eighth; it is possible that having done the Turn-end and Affect function tasks he was becoming more aware of prosodic function in speech.

#### **4.2. Turn-end**

Pragmatically, a person who does not understand intonation as used in this task may not understand that different ways of saying utterances can elicit different types of response; expressive deficit may result in not using intonation at turn-ends to indicate the type of response wanted or expected. Adam's scores, like those of the other children with HFA, were similar to his TD peers on these tasks (especially the input task) so little can be deduced from the comparison. Figure 1 shows however that these skills do not develop fully in the TD group until a later age than the mean chronological age of Adam's TD peer-group (6;2), so the developmental factor may mask a difference here.

#### **4.3. Affect**

Adam scored 5 standard deviations below his TD peers on the AI task and 3 standard deviations below on the AO task. Figure 2 shows that his peers with HFA scored better than Adam on both tasks, but their scores were significantly different –  $p < .01$  – from the TD group. Deficit in the input skill suggests that a speaker may find it difficult to interpret other people's feelings from intonation alone (or may not understand the concept that others have feelings); deficit in the output skill may make for inconsistency or unpredictability in using intonation to make feelings known.

#### **4.4. *Chunking***

We hypothesise that the effect of reduced chunking ability in conversation is that the phrasing of speech may sound unusual. Reduced receptive ability may mean that the speaker interrupts interlocutors, or does not answer when expected, or gets confused in processing long utterances. Such effects would impinge on conversational-pragmatic skills.

The TD group scores low on these tasks, but this probably reflects their young age; Figure 1 suggests that these are skills which are not fully developed until after the chronological age of 7 at least. In the input tasks Adam scores marginally better than his TD peers but not as well as his peers with HFA. In the output task, Adam's score is just better than his TD peers and markedly better than his peers with HFA. This score appears to be reflected in his conversation; the phrasing of his speech is not atypical.

#### **4.5. *Focus***

In conversation, lack of ability in the receptive skill may mean that the hearer misses the emphasis or the main point of what is said, if it is only signalled by prosody (place of stress). Stress-placement is also part of the lexical specification of words, and so individual words may be misheard or misunderstood. On the input task, TD children of Adam's age tend to score at chance, and Adam scores at the same level as his peers of both groups.

By contrast, ability in the Focus output task is one that the youngest children in the study acquire first, and Figure 1 shows that there is little difference in scores between the youngest children and the adults. Adam scored more than 3.5 standard deviations below his TD peers, and markedly less well than his peers with HFA (who nevertheless were significantly different from the TD group:  $p < .01$ ). His errors show some misplaced and some ambiguous stresses. His speech shows some evidence of syllable timing (equal stress), but it was not so marked as to make all words sound equally salient. As far as conversational-pragmatic skills are concerned, stress that is well-formed (and therefore apparently intentional) but misplaced is likely to be disconcerting and occasionally misleading.

#### **4.6. *Summary of prosodic scores***

Adam's performance on prosody tasks is variable, and in this he is similar to the other children with autism. His scores are marginally better on the tasks involving longer items (Chunking, Focus and the Prosody form tasks) than on those with shorter items (Turn-end, Affect and the related Intonation form tasks). He does however show a tendency to misplace stress, a finding that agrees with other studies of prosody in autism (e.g. Baltaxe 1984, Shriberg et al., 2001). His auditory discrimination is apparently disordered, and his imitation skills variable. His performance on the Affect tasks is relatively lower than on those involving linguistic functions; this was perhaps to be expected for a child with autism of reasonable verbal ability (his verbal mental age is close to his chronological age).

#### 4.7. *Pragmatic assessment*

As expected, because of the presence of autism, Adam scored low on the CCC's pragmatic composite: his score was 98, where scores lower than 132 indicate a degree of impairment (Bishop, 1998).

Prosody can have little part to play in CCC categories such as vocabulary, topic-choice, gaze and facial expression, direction of talk (i.e. to what people); and decentring (as in realising a need to explain referents). In some CCC questions, however, expressive prosody is likely to play some part, although only one makes this clear in its formulation:

#30: *"pronounces words in an over-precise manner; accent may sound rather affected or 'put-on'"*

Adam's accent is not like that of his peers, and in the CCC assessment the following comments are also reported as applicable to Adam. We indicate below how the prosodic skills in which Adam scored low could have a role in them:

#22: *"what he says seems illogical and disconnected": this might be an effect of stressing the wrong words.*

Receptive prosodic ability (specifically the ability to understand affect as expressed by tone of voice) is clearly likely to have a role in the following questions:

#41: *"cannot understand sarcasm"*

#48: *"doesn't seem to read...tones of voice and may not realise when people are upset or angry"*

and other receptive prosodic skills may be involved in the following:

#32: *"will suddenly change the topic of conversation"*

#34: *"conversation tends to go off in unexpected directions"*

*These two may be related to an inability to interpret types of conversational turn-ends.*

*The following issues:*

#39: *"ability to communicate clearly seems to vary a great deal from one situation to another"*

#40: *"takes in just one or two words... and often misinterprets what is said"* may depend on fluctuating sensory reception, but may also be the result of failing to understand prosody/intonation. As already suggested, a misreading of stress-placement could lead to misinterpretation of the words and main point of what is said.

At the time of testing, a small sample of Adam's conversation was recorded, around a task in which he assembled some picture-cards and then related the story they suggested. As small examples of how prosodic deficit may impact on conversational-pragmatic skills, here are two exchanges between Adam and his interviewer, Jane. Stressed (focal) items are italicised:

Jane     you need to find the one that comes *first*  
Adam     that one comes *first*

Jane     think it might be a *birthday* party  
Adam     yeh it might be a *birthday* party

Adam appears to understand what Jane is saying and to be responding to it with appropriate content and appropriate timing. Rather unusually, however, he does not reduce or pronominalise Jane's utterances in his responses. This is not unknown in conversation between people without impairment, although it usually serves some



particular communication function (e.g. demonstrating complete understanding). When lack of pronominalisation occurs in typical speech, however, any word that is different from the original utterance is usually stressed by way of contrast, as in the PEPS-C Focus output task:

A        the red cow's got it  
B        No, the *white* cow's got it  
So in this case we might have expected:  
Jane     you need to find the one that comes *first*  
Adam    *that* one comes first  
and  
Jane     think it might be a *birthday* party  
Adam    yeh it *might* be a birthday party

but Adam, in stressing the same words that Jane stresses, fails to use contrastive stress according to the usual rules (as reflected in his low PEPS-C Focus output score); and such utterances are not untypical of Adam's speech. The effect of this is subtle: he fails to some extent to acknowledge what Jane has said, thus missing a chance to affiliate conversationally with her. He sounds as though he has not quite heard, or not fully grasped the point, or that he had thought of saying the same thing independently. It does not occasion conversational repair, and is probably not registered by his interlocutor as a speech disorder, but has instead a social or interactive effect, i.e. he sounds a little competitive, or out of sympathy with her.

## 5. Conclusion

The quantification and precise description of atypical expressive prosody - whether in Adam, in autism in general, or in other conditions - remains a challenge; but in summary, the prosody assessment described here suggests some specific functional problems in this child's prosody: deficit in the ability to understand some specific meaning-differences conveyed by prosody, and low ability to convey meanings via prosody. There appears to be some evidence of the findings for his expressive prosodic skills in a small amount of conversational data. We have also shown how the CCC indicates a measure of pragmatic deficit, and the role that prosodic skills may play in this. Prosodic deficit is seldom addressed by speech and language therapists (despite the fact that overt prosodic atypicality such as Adam's may have an impact on his social acceptance). However, the PEPS-C offers a way of assigning prosodic impairment to a specific level/mode of processing, and in conjunction with the CCC it is possible to identify aspects of communication that may be affected as a result of prosodic deficit. This makes it possible to plan intervention (e.g. developing awareness of prosodic function) so that it targets a need directly.

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## Appendix: Description of PEPS-C tasks

Level	Mode	Task Name	Abbr.	Description
Form	Input	Intonation Input	II	Auditory discrimination of intonational forms in one- and two-syllable words without reference to meaning. Stimuli are laryngograph recordings of items from the Turnend and Affect input tasks.
	Output	Intonation Output	IO	Assesses whether an individual has the voice skills required to imitate various intonational forms. Stimuli consist of items similar to those in Turnend and Affect tasks.
	Input	Prosody Input	PI	Discrimination of prosodic forms in short phrases without reference to meaning. Stimuli consist of laryngograph recordings of items from the Chunking and Focus input tasks.
	Output	Prosody Output	PO	Imitation of long prosodic forms. Stimuli consist of items similar to the Chunking and Focus tasks.
Function	Input	Turnend Input	TI	Comprehending whether an utterance requires an answer or not: single words with intonation suggesting either questions or statements.
	Output	Turnend Output	TO	Producing single words with intonation suggesting either questioning or stating.
	Input	Affect Input	AI	Comprehending liking or disliking as expressed on single words.
	Output	Affect Output	AO	Producing affective intonation to suggest either liking or disliking on single words.
	Input	Chunking Input	CI	Comprehending prosodic phrase boundaries. Items are syntactically ambiguous phrases, e.g. “chocolate-biscuits and jam” versus “chocolate, biscuits and jam”.
	Output	Chunking Output	CO	Producing prosodic phrase boundaries in phrases similar to those above.
	Input	Focus Input	FI	Comprehension of contrastive stress.
	Output	Focus Output	FO	Production of contrastive stress.